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# MOOD CONTROLLED LIGHT

ANISHAZIELA BINTI AZIZAN

A report submitted in partial fulfilment of the
requirements for the award of the degree of
Bachelor of Engineering (Electrical-Electronics)

Faculty of Electrical Engineering
Universiti Teknologi Malaysia

MAY 2011

I declare that this project entitled *"Mood Controlled Light"* is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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*Specially dedicated,*

*To my beloved mother,*

***Hajar Bt. Hanapiah,***

*To my sisters, brothers, lecturers and fellow friends*

*for their encouragement*

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Alhamdulillah, praise to Allah S.W.T., the Most Merciful and the Most Compassionate for His wills and blesses along this journey of life. Peace is upon him, the messenger of God, Nabi Muhammad S.A.W,

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# ABSTRACT

*Biofeedback is the* most effective and widely-used performance-enhancing disciplines used in clinical, government, and military applications. Biofeedback gives information about the human body using externals instruments. There are many physiological processes that can be monitor for biofeedback applications such as temperature, heart rate, EMG (electromyography), BSR (Basal skin response), respiration and neurofeedback (EEG). Basically, the purpose of this project is to measure the heart rate of a person and change the environment colour in order to stabilize back the person mood. So, the polar heart rate monitor was used to measure the heart rate electrically. Then the compatible receiver will receive the data wirelessly by following the rules of the orientation between the transmitter and receiver. In order to process the information measured, the MikroC Pro was used to program the microcontroller. In this project, there will be three range of heart rate which are anxiety, sleepy and resting mode. As to stabilize back the person's mood, the LED strip used to display the output whether red, green or blue depend on the information detected and change the environment colour. This is because; colour therapy believable can give impact to the emotional state of human. In conclusion, the heart rate was successfully measured and the MikroC Pro was developed to change the environment colour as to stabilize back the emotion of a person at certain time.

# ABSTRAK

Biofeedback adalah merupakan disiplin bagi meningkatkan prestasi yang paling berkesan dan banyak digunakan dalam bidang klinikal, kerajaan, dan aplikasi tentera. Biofeedback memberikan maklumat tentang diri kita dengan menggunakan instrumen luaran. Terdapat pelbagai proses fisiologi yang dapat memantau aplikasi biofeedback contohnya adalah seperti suhu, degupan jantung, EMG (elektromiografi), bsr (Basal respons kulit), pernafasan dan neurofeedback (EEG). Pada dasarnya, tujuan projek ini dijalankan adalah untuk mengukur denyut jantung seseorang dan menukar warna persekitaran bagi menstabilkan kembali emosi seseorang individu. Maka, alat untuk mengukur denyut jantung jenis kutub digunakan untuk mengukur denyut jantung secara elektrik. Kemudian penerima yang serasi akan menerima data tanpa kabel dengan mengikuti Peraturan orientasi antara pemancar dan penerima. Bagi memastikan maklumat yang diukur dapat diproses, maka MikroC Pro digunakan untuk program mikrokontroler. Dalam projek ini, terdapat julat kadar degupan janting iaitu gelisah, mengantuk dan mod rehat. Bagi menstabilkan kembali emosi dan perasaan seseorang, LED strip digunakan untuk memaparkan output sama ada merah, hijau atau biru bergantung kepada maklumat yang dikesan dan kemudiannya menukar warna persekitaran. Hal ini kerana; terapi warna dipercayai dapat memberikan kesan terhadap keadaan emosi manusia. Kesimpulan, denyut jantung berjaya diukur dan MikroC Pro dibangunkan untuk menukar warna persekitaran untuk menstabilkan kembali emosi seseorang pada waktu tertentu.

# TABLE OF CONTENTS


| CHAPTER | TITLE | | PAGE |
|---|---|---|---|
| | **DECLARATION OF THESIS** | | **ii** |
| | **DEDICATION** | | **iii** |
| | **ACKNOWLEDGEMENT** | | **iv** |
| | **ABSTRACT** | | **v** |
| | **ABSTRAK** | | **vi** |
| | **TABLE OF CONTENTS** | | **vii** |
| | **LIST OF TABLE** | | **ix** |
| | **LIST OF FIGURE** | | **x** |
| | **LIST OF APPENDICES** | | **xii** |
| **1** | **INTRODUCTION** | | |
| | 1.1 | Research Background | 1 |
| | 1.2 | Problem Statement | 2 |
| | 1.3 | Objective of Study | 3 |
| | 1.4 | Scope of Study | 3 |
| | 1.5 | Outline of Thesis | 4 |
| **2** | **LITERATURE REVIEW** | | |
| | 2.1 | Introduction | 5 |
| | 2.2 | Heart Rate | 5 |
| | | 2.2.1 Manual Method of measuring Heart Rate | 7 |
| | | 2.2.2 Monitor method of measuring Heart Rate | 8 |
| | 2.3 | Microcontroller | 9 |

| | | | |
|---|---|---|---|
| | 2.3.1 | PIC Microcontroller | 10 |
| | 2.3.2 | PIC18F452 Microcontroller | 10 |
| 2.4 | | MikroC Pro for PIC | 11 |
| 2.5 | | Colors and Person's Emotion | 13 |
| 2.6 | | Color Mood Chart | 16 |
| **3** | **METHODOLOGY** | | |
| 3.1 | | Introduction | 17 |
| 3.2 | | Project Overview | 18 |
| 3.3 | | Hardware Development | 19 |
| | 3.3.1 | Measuring the Heart Rate | 19 |
| | 3.3.2 | Heart Rate Receiver | 20 |
| | 3.3.3 | Orientation of Receiver with Polar Transmitter | 22 |
| | 3.3.4 | Microcontroller | 23 |
| | 3.3.5 | LED Indicator | 24 |
| | 3.3.6 | Liquid Crystal Display | 26 |
| 3.4 | | Software Development | 27 |
| | 3.4.1 | MikroC Pro | 27 |
| **4** | **RESULT AND DISCUSSION** | | |
| 4.1 | | Introduction | 33 |
| 4.2 | | Hardware | 33 |
| 4.3 | | Software | 36 |
| 4.4 | | Result | 38 |
| 4.5 | | Discussion | 40 |
| **5** | **CONCLUSION AND RECOMMENDATION** | | |
| 5.1 | | Introduction | 41 |
| 5.2 | | Conclusion | 41 |
| 5.3 | | Recommendations | 43 |
| **REFERENCES** | | | **44** |
| Appendices A | | | 46 |

# LIST OF TABLE


| TABLE NO. | TITLE | PAGE |
|---|---|---|
| 2.1 | Normal heart beat range | 6 |
| 2.2 | Definition of color | 16 |
| 3.1 | Pin descriptions of RMCM01 | 21 |
| 3.2 | PIC18f452 pin connection | 24 |
| 3.3 | Pin definition of HL1606 | 25 |
| 3.4 | LED control byte format | 30 |
| 3.5 | LED control bit format | 31 |
| 3.6 | Available color | 32 |
| 4.1 | Pin descriptions of SK40C | 36 |
| 4.2 | Result obtained from the overall project | 39 |

# LIST OF FIGURES


| FIGURE NO. | TITLE | PAGE |
|---|---|---|
| 2.1 | Graph of heart beat | 7 |
| 2.2 | Manual method | 7 |
| 2.3 | Monitor method | 9 |
| 2.4 | Pin diagram of PIC18f452 | 10 |
| 2.5 | MikroC Pro for PIC IDE | 12 |
| 2.6 | The Wheel of Life | 13 |
| 3.1 | The project's flowchart | 17 |
| 3.2 | Project Block Diagram | 18 |
| 3.3 | T31 Transmitter | 19 |
| 3.4 | RMCM01 | 20 |
| 3.5 | Diagram of RMCM01 | 20 |
| 3.6 | Schematic of polar hear rate receiver | 21 |
| 3.7 | Placement of the transmitter and receiver component | 22 |
| 3.8 | Voltage regulator | 24 |

| | | |
|---|---|---|
| 3.9 | Schematic of PIC18F452 | 24 |
| 3.10 | Diagram of HL1606 | 25 |
| 3.11 | Connection of LCD display | 26 |
| 3.12 | 2x 16 LCD | 26 |
| 3.13 | Flowchart of MikroC Programming | 28 |
| 3.14 | Flowchart of MikroC programming | 29 |
| 4.1 | First design by using Altium design | 34 |
| 4.2 | Top view | 35 |
| 4.3 | Side view | 35 |
| 4.4 | Bottom view | 35 |
| 4.5 | Programming for anxiety emotion | 36 |
| 4.6 | Programming for sleepy emotion | 37 |
| 4.7 | Programming for resting emotion | 37 |
| 4.8 | Messages in the MikroC Pro | 38 |
| 4.9 | Relation between the input and output | 38 |

# LIST OF APPENDICES


| APPENDIX | TITLE | PAGE |
|---|---|---|
| A | MikroC Pro programming for Mood Controlled Light | 46 |

# CHAPTER 1

# INTRODUCTION

## 1.1 Research Background

Biofeedback refers to a process of measuring body natural rhythm such as breathing and heart rate in which the electrodes placed on skin or fingertips [1]. The result of the measurement can be analyzed by a professional where displayed on a monitor. According to the University of Maryland Medical Centre, there are three types of biofeedback which are electromyography, thermal feedback and neurofeedback [1]. Electromyography measures muscle tension whereas thermal feedback focusing on skin temperature and neurofeedback(EEG) works with brain waves.

Emotions play an important role throughout the span of lives because they enrich virtually all of person waking moments with either a pleasant or an unpleasant quality [2]. A study made by Marvin Wernick in the year of 1975 has shown that there is a ring that able to indicate the wearers' mood based on body heat and emotional state of the wearer [3]. When you wear the ring, your mood will be determined based on the color of the stone. As an example, if the stone turn to a dark blue color, then it shows that you are happy. While, if you are feeling stressed, then the stone color will change to a very black color.

However, in this project biofeedback application that will be used is heart rate monitor. Once the person's mood is known by measuring the heart rate of the person's, then the surrounding color of the room will change according to color mood chart. This technique hopefully can stabilize back the person mood because color therapy uses color to treat mental, emotional and physical problems and restore the whole person to health and harmony [4].

"When children under detention at the San Bernardino County Probation Department in California become violent, they are put in an 8-foot by 4-foot cell with one distinctive feature - it is bubble gum pink. The children tend to relax, stop yelling and banging and often fall asleep within 10 minutes".

(Paul E. Boccumini, director of clinical services for the department)

## 1.2 Problem Statement

There are problem with mood rings which it cannot really show person's mood scientific accuracy. Actually, a mood ring stone is filled with thermo tropic liquid crystal. The crystal is very sensitive because it changes due to changing of surrounding temperature and atmosphere. So, the mood rings not indicate the person's mood accurately.

Besides, nowadays, we are able to detect someone anger but we could not find certain way to overcome their angry.

Due to these problems, in this project the person's mood will be determined by measuring the heart rate and then the surrounding colour will change as to handle well these problems.

## 1.3 Objective of Study

Based on the problem statement above, this project was designed to stabilize the person's emotion by changing the environment color. By managing our emotion, it may improve our heartbeat and perhaps put us on the path to health [1].

So, as to realize this project, several objectives have been decided. The interface between the polar heart rate transmitter and receiver with the PIC18F452 is essential to ensure that the device able to communicate effectively. The objectives of this project are:

- To determine person's mood based on biofeedback by measuring heart rate.
- To develop a system to gather data from heart rate strap.
- To change environment color based on persons; mood.

## 1.4 Scope of Study

As to achieve all of the objectives, the scope was divided into two main parts which are hardware and software. For the hardware part, the circuit that connect the heart rate transmitter and receiver and also the display output was build. As to know the range of the heart rate of a person's, the mikroC software was used to program the PIC18F452.

## 1.5 Outline of Thesis

In this thesis, there are five chapters. The objective and scope of the project is discussed in Chapter 1. In Chapter 2, the literature review will be discussed while Chapter 3 will cover up the research methodology for this project. The result and discussion will be explained in Chapter 4. The last chapter which is Chapter 5 will conclude about this project and a few recommendations will be suggested in that chapter.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

This chapter is about the literature review that related to the work. In this chapter, the device overview and mikroC software will be explained. There are mainly about heart rate, microcontroller and mood color chart.

## 2.2 Heart Rate

Heart rate is measured in beats per minute (bpm). If we are stress, our heart rate will increase. While when we are afraid, the beats per minute will increase more. In the contrast, if we are in depression, the heart rate is lower. There are various ways to measure heart rate such as by using pulse oximeter, heart rate monitor and electrocardiograph. The beats per minute is differ for many people which depending on the ages, body physical condition and environmental factor. Table 2.1 shows the normal heart rate according to age.

**Table 2.1** : Normal heart beat range

| **Period** | **Heart Rate** |
|---|---|
| Newborn (baby) | 100-160 bpm |
| Younger children (1-10 years) | 70-120 bpm |
| Teenager (10-17years) | 70-100 bpm |
| Adults | 60-100bpm |

There are a few factors that can influence heart rate such as [5]:

1. Activity level
2. Fitness level
3. Air temperature
4. Body position (standing up or lying down, for example)
5. Emotions
6. Body size
7. Medication use

In this project, we will discuss how emotions will influence person's heart rate. There will be three range of heart rate which represent of three emotions. The emotions are anxiety, sleepy and resting. Range of heart rate for anxiety is between 120-160 bpm[6]. While the range of heart rate for sleepy is from 57 bpm to 61 bpm[7]. The last one is the range for resting. The heart rate range is between 62-69 bpm[8].

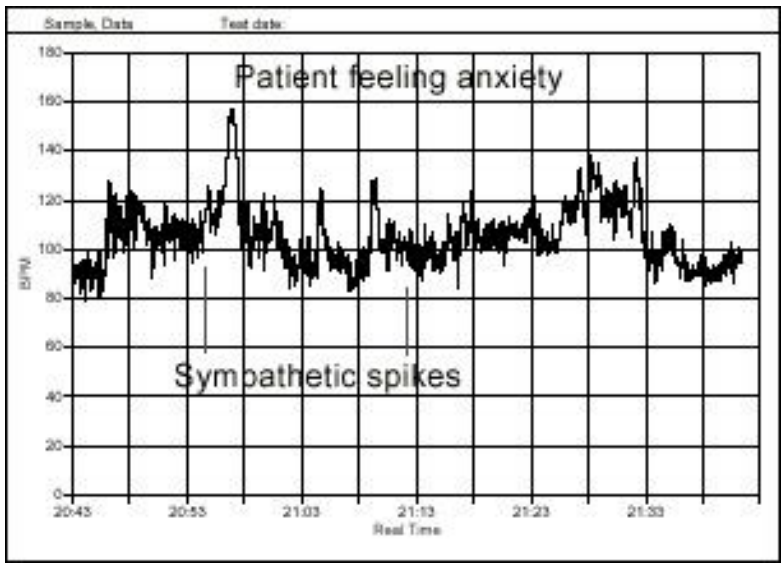



**Figure 2.1** : Graph of heart beat

### 2.2.1 Manual Method of measuring Heart Rate

Heart rate of a person can be measure at where an artery is close to the surface and at a pulse can be felt. The most common places to measure heart rate using the palpation method is at the wrist (radial artery) and the neck (carotid artery) [9]. Other places sometimes used are the elbow (brachial artery) and the groin (femoral artery)[9]. To take someone else's pulse, fingers should be used not thumb.

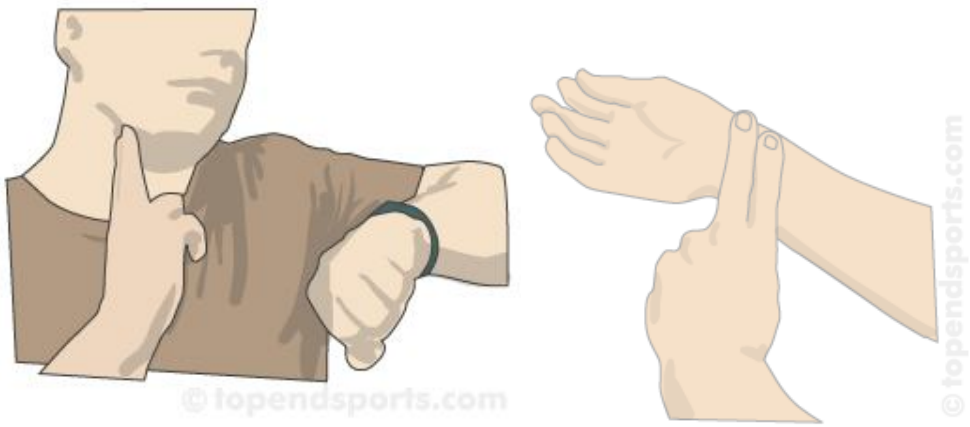



**Figure 2.2** : Manual method

1. **Carotid Pulse (neck)** - Place first two fingers on either side of the neck carefully. Then, count the number of beats for a minute.
2. **Radial Pulse (wrist)** - Place index and middle fingers together on the opposite wrist, about 1/2 inch on the inside of the joint, in line with the index finger. Count the number of beats within a one minute period once fined a pulse.

There should be an estimation the per minute rate by counting over 10 seconds and multiplying this figure by 6, or count over 15 seconds and multiply by 4, or over 30 seconds and doubling the result[9]. However, by using this shorthand method there will be potential errors obviously.

### 2.2.2 Monitor method of measuring Heart Rate

In order to get more accurate and precise value of heart rate measurement, heart rate monitor, ECG or EEG can be used. The motions of exercise make it the measurement of heart rate difficult to be done manually. That is why monitor method is important to be used during exercise especially. Besides, a heart rate monitor is also useful in the short time periods of heart rate changing. Many heart rate monitors require at least a little body perspiration between the chest strap and the skin for best conduction of the signal and ensure that there is a good connection between the chest strap and chest.[9]. As to increase the conductivity, some water or other fluid can be added.

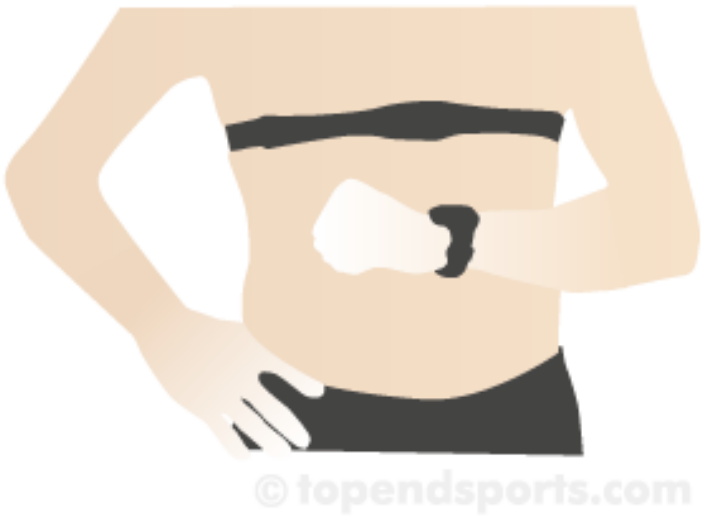



**Figure 2.3** : Monitor method

## 2.3 Microcontroller

Microcontroller is a small computer on a single integrated circuit that contains a processor core, memory and programmable input/output peripherals designed for embedded system applications[10]. As to execute only single specific task to control a single system, the microcontroller was designed. It contains all the function required on a single chip such as:

1. Central Processor Unit (CPU)
2. RAM
3. ROM
4. Input/output Port
5. Bus System
6. Timer
7. Others special function such as ADC,PWM and USART

Microcontrollers are often used in automatically controlled product and device such as implantable medical devices, remote controls, appliances, automobile engine control system and toys[11].

### 2.3.1 PIC Microcontroller

PIC stands for Programmable Interface Controller originally developed by General Instrument's Microelectronic Division[12]. Because of its lower cost, wide availability and serial programming capability it is become popular among industrial and personal purposes[12]. In order to operate the design function, PIC needs to be programmed. There are a few software that can be used to program the PIC whether MikroC, MPlab and ICSP as example. PIC microcontroller has many families that categorized due to its function, ability and features. The PIC 18 series is a popular PIC microcontroller due to many applications and manufactures demand. Its features include high pin count, high density and complex applications [13]. PIC is the most popular 8-bit chip in the world, used in a wide variety of applications[14].

### 2.3.2 PIC18F452 Microcontroller

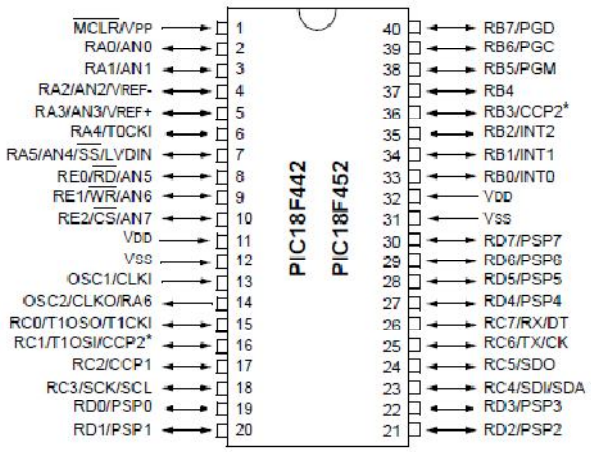



**Figure 2.4** : Pin diagram of PIC18f452

For general purpose applications written in C, the PIC18F452 microcontrollers offer cost efficient solutions require a complex communication protocol stack. PIC18F452 devices have flash program memory with 32Kbytes and

data memory with 256bytes which operate in a range between 2.0 to 5.0 volts. The operating frequency is from DC to 40MHz. Figure 2.4 above shown the pin configuration diagram of PIC18F452 (DIP package).

Besides, the PIC18F452 has five parallel ports which are PORTA, PORTB, PORTC, PORTD, and PORTE. The PIC18F452 also have built-in hardware called USART (universal synchronous/asynchronous receiver-transmitter) to implement a serial communication interface which is at pin 26 (RX) and pin 27 (TX). Moreover, this PIC also can be used for SPI mode.

## 2.4 MikroC Pro for PIC

The mikroC PRO for PIC is a powerful, feature-rich development tool for PIC microcontrollers[14]. In developing applications for embedded systems without compromising performance or control, it was designed to provide the easiest solution for the programmer. MikroC PRO for PIC provides a successful match featuring highly advanced IDE, ANSI compliant compiler, broad set of hardware libraries, comprehensive documentation, and plenty of ready-to-run examples[14].

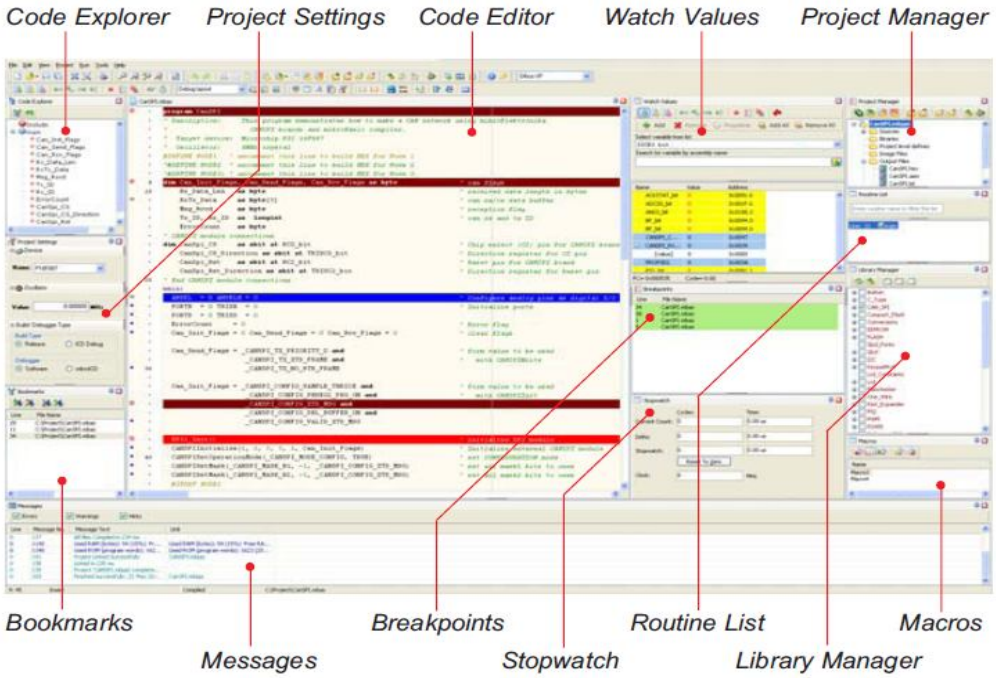



**Figure 2.5** : MikroC Pro for PIC IDE

There are few features for MikroC Pro for PIC which are[14]:

1. Write your C source code using the built-in Code Editor (Code and Parameter Assistants, Code Folding, Syntax Highlighting, Auto Correct, Code Templates, and more.)
2. Use included mikroC PRO for PIC libraries to dramatically speed up the development: data acquisition, memory, displays, conversions, communication etc.
3. Monitor your program structure, variables, and functions in the Code Explorer.
4. Generate commented, human-readable assembly, and standard HEX compatible with all programmers.
5. Use the integrated mikroICD (In-Circuit Debugger) Real-Time debugging tool to monitor program execution on the hardware level.
6. Inspect program flow and debug executable logic with the integrated Software Simulator.
7. Generate COFF (Common Object File Format) file for software and hardware debugging under Microchip's MPLAB software.

8. Active Comments enable you to make your comments alive and interactive.
9. Get detailed reports and graphs: RAM and ROM map, code statistics, assembly listing, calling tree, and more.
10. mikroC PRO for PIC provides plenty of examples to expand, develop, and use as building bricks in your projects. Copy them entirely if you deem fit – that's why we included them with the compiler.

## 2.5 Colors and Person's Emotion

Mood is a temporary state of mind or temper[15] . There is the Wheel of Life which describes the emotions of change [16].

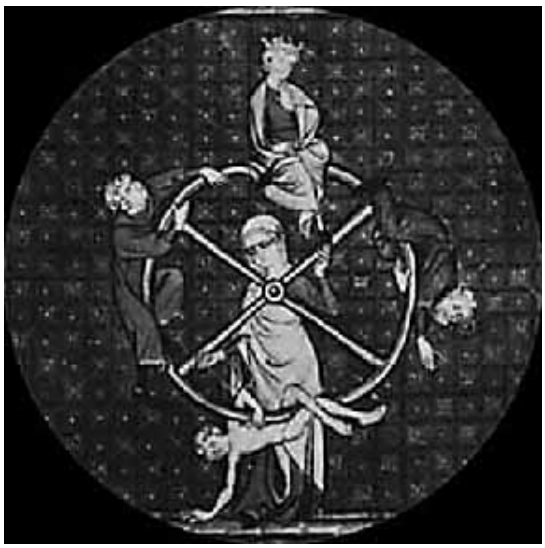


**Figure 2.6** : The Wheel of Life

At the top of the wheel is a well-dressed, smiling, kingly or queenly person. This person is in the position of *Happiness* which represent things are normal and going well. The wheel turns with a clockwise movement, the same person is now upside down and falling through space with a look of distress. This is the position of *Loss*. The wheel continues its movement and at the bottom of the wheel the individual is now nude. This is the position of *Suffering*. The wheel turns again and

rises up to the position of *Hope*. So, it clearly shown that there are only four positions in life which are happy, loss, suffering and hope. People are always in one of these positions. Many things happen in life can affect emotional health which leads of feeling sadness, stress and anxiety. These things are include [17]:

- Being laid off from job
- Having a child leave or return home
- Dealing with the death of a loved one
- Getting divorced or married
- Suffering an illness or an injury
- Getting a job promotion
- Experiencing money problems
- Moving to a new home
- Having a baby

Many people don't realize that color can affect our physical bodies and emotional state at certain time. As we can see, there will be a lot of warm colors on the walls of kindergarten room. Actually, the learning become more fun with these color because colors can stimulate brain functioning [18]. From clinical studies in 1990, flashing red lights were shown in the eyes of migraine sufferers at the start of an attack using special goggles which the light intensity and the frequency of flashing could be altered [4]. Ninety-three percent of patients had some relief from the treatment with 72 percent reporting that severe migraines could be stopped within one hour [4]. Lights of a higher intensity and greater flashing frequency were found to be the most effective way to conduct the patient. As example, light room therapy was effective in reducing depressive symptoms in subjects with winter depressive mood [19].

Besides, scientist has found also that color can affect person mood not just only used to lighten up a room [18]. Moreover, some also have found that the most important keys lead to relaxation is color. Form the side of health practitioners, they have experimented with color and it shows that color can impact to a person's state

of mind and health. The experiment done by Researcher Robert Gerard result that, when a person look at the red light, their blood pressure and heart rate will increase while their blood pressure will dropped by looking at the blue light. Gerard also found that colors with longer wavelengths (the warm colors that are red, yellow and orange) tense up, while shorter wavelengths (cooler colors like blue, purple and green) cool down the emotion. For the color therapist, there are many ways to apply the properly colored light to the patient. Sometimes a color crystal torch is used by the therapist to transmit the chosen color onto the patient's body. Some other techniques are like direct light, gems, and jewelry, perfume, clothing and colored glass. Besides, patients can also eat the appropriately colored foods. It shows how significant color can give impact to the patient by color therapist.

The general perception of cool and warm colors is universal in which each individual may have different feeling toward certain colors according on how they affect us physically, emotionally, and spiritually. As a clear example, if your best friend always wears blue you may relate that color with him or her, and so it may influent you differently with others.

## 2.6 Color Mood Chart

There are some explanations about basic colors which were summarized as shown in the table below:

**Table 2.2**: Definition of color[4]

| Color | Definition |
|---|---|
| Blue | • often used in bedrooms<br>• slows metabolic activity<br>• pain relieving<br>• enhance clear thinking |
| Green | • symbolic or nature<br>• calming and refreshing color<br>• can relax patients in hospitals |
| Red | • stimulate the heart to beat faster<br>• increase metabolic activity<br>• color of love |
| Yellow | • cheerful color<br>• most people lose their tempers and anger in yellow rooms<br>• enhance concentration<br>• speed up metabolism |
| Purple | • powerful color in enhancing creativity |

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

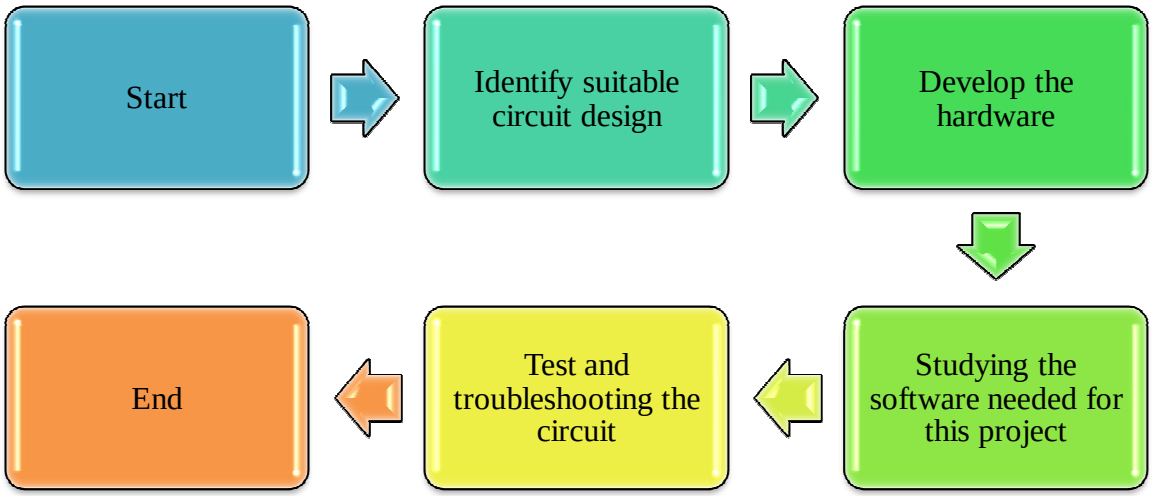



**Figure 3.1** : The project's flowchart

The overall project flow is shown in Figure 3.1. The project start by gathering all data and information needed for developing the system. By knowing the right circuit design and choose the best components to use for the hardware is the right way to start the project. While developing the hardware, the suitable software needs to be studied in order to ensure that the hardware development can communicate well with the software design. After completing software and hardware design, the circuit needs to be test and do troubleshooting to ensure that the circuit can function successfully due to desire output. Then, the overall steps are done.

## 3.2 Project Overview

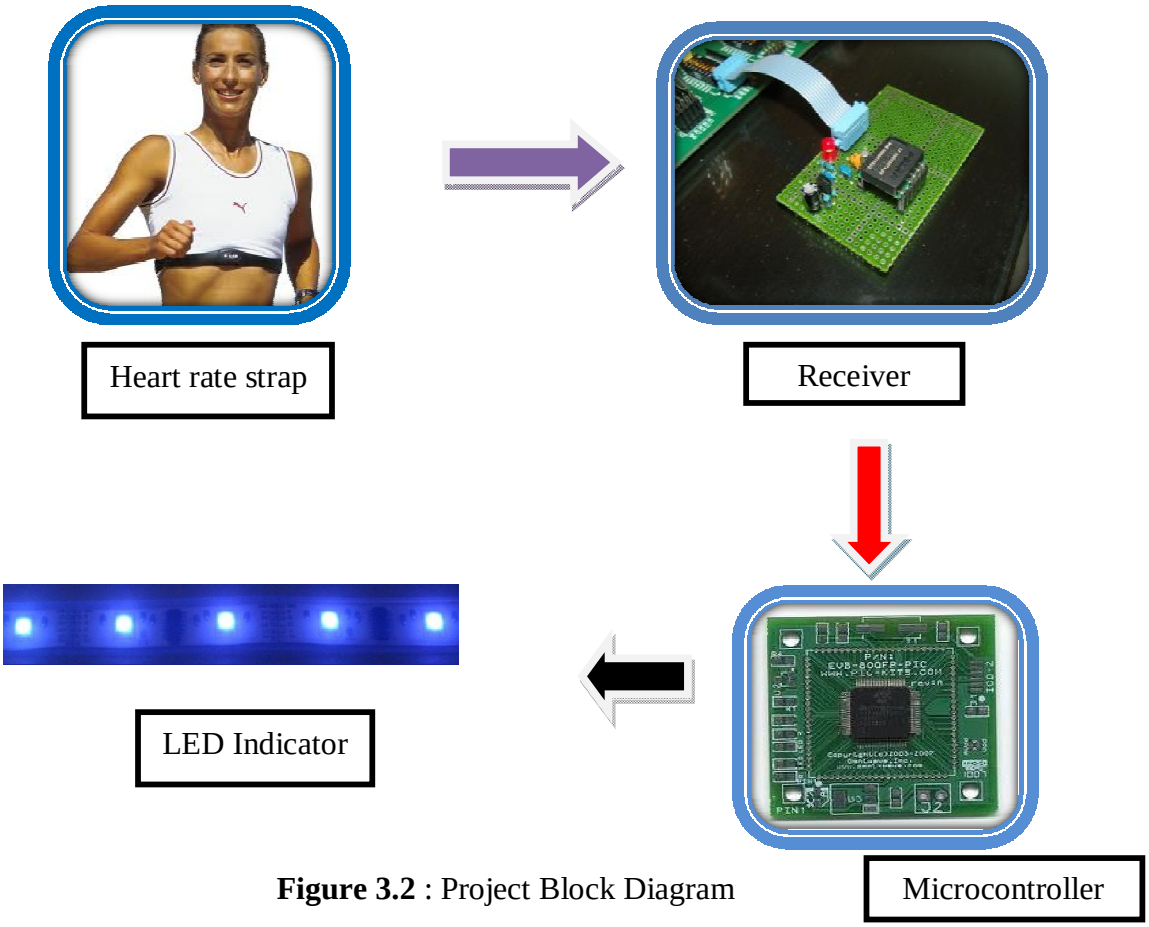



**Figure 3.2** : Project Block Diagram

The figure 3.2 shows the project overview which consist of four basic components. The heart rate strap was used to measure the heart rate. Then, the data will be sent to the receiver wirelessly.

The microcontroller which is PIC18F452 has been programmed as to process the data received by the receiver. The range of the heart beat has been divided into three ranges which are sleepy, anxiety and last but not least is resting.

As to display the output, led strips were used. The output colour displayed is depending on the range of the heart rate detected by the receiver whether sleepy, anxiety or resting emotions.

## 3.3 Hardware Development

### 3.3.1 Measuring the Heart Rate

In this project, the type of heart rate monitor that will be used to measure heart beat is Polar Heart Rate Monitor (T31 Transmitter). The heart beat will be detected electrically by wearing the transmitter around the chest. Every heart beat detected through two electrodes of the Polar Transmitter with ECG accuracy. The heart rate information was then transmitted to Polar RMCM-01 receiver wirelessly with the help of a low frequency electromagnetic field [20].

**Figure 3.3** : T31 Transmitter

### 3.3.2 Heart Rate Receiver

The receiver that compatible with the Polar Heart Rate Transmitter is RMCM01. The polar heart rate receiver received the heart rate signal from Polar transmitter belt wirelessly. The receiver that is installed on end user equipment receives the signal and generates a corresponding digital pulse that is operated on by the end user equipment electronics [20].

**Figure 3.4** : RMCM01

**Figure 3.5** : Diagram of RMCM01

**Table 3.1** : Pin descriptions of RMCM01

| Pin Name | Description |
|---|---|
| HR | Heart beat information 3V positive pulse, 1ms. |
| Reset | Reset |
| OSC | Crystal terminal |
| F32KIN | Crystal terminal or DC isolated clock input |
| OSC_ON | Clock section (input/output) |
| WIDB_DET | Settings. Connect to Vcc. |
| FPLS | Pulse detector output 3V positive pulse, 6ms nominal width. |
| LX2 | Antenna coil terminal |
| LX1 | Antenna coil terminal |
| GND | Ground |
| VCC | Operating voltage |

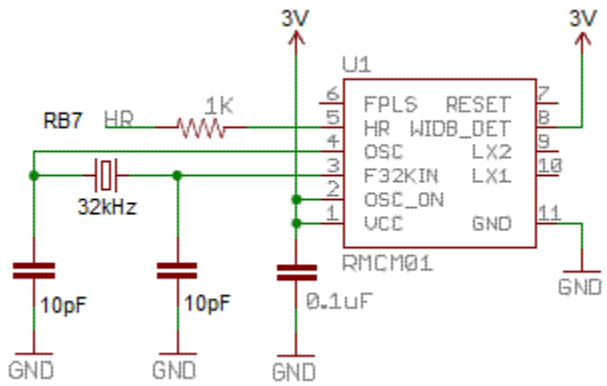



**Figure 3.6** : Schematic of polar hear rate receiver

Figure 3.6 shows the schematic of polar receiver. The output from the Polar RMCM01 module was connected to Port B pin 0 (RB0) of the development board as an input to the microcontroller.

This polar receiver was used in this project due to the advantages of the receiver. The advantages of the receiver were listed as below:

- designed to be used in constant noise
- small size, easy to find a place inside end user equipment
- working with all Polar transmitter belts
- SMD component for Pick & Place machine
- Coded and non-coded receiver

### 3.3.3 Orientation of Receiver with Polar Transmitter

In order to transmit data to the RMCM-01 receiver on the HRMI board, the Polar transmitters use a magnetic field. In order to get the maximize signal transfer between a polar transmitter and the HRMI, the following rules need to be followed [21]:

- The maximum distance between the transmitter and HRMI should not exceed 80 cm.

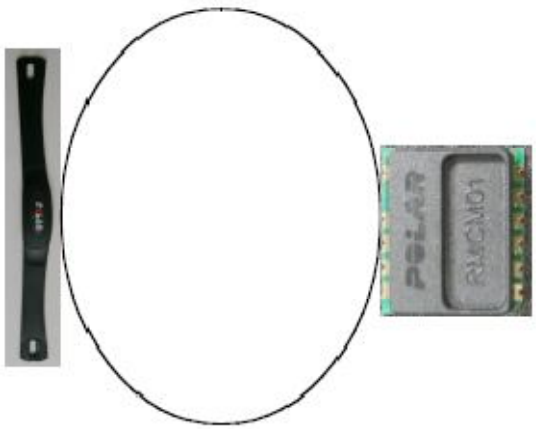



**Figure 3.7** : Placement of the transmitter and receiver component

- The magnetic field is generated and detected using coils in the transmitter and receiver. The receiver coil should be in parallel with the magnetic flow

generated by the transmitter for maximum energy transfer as illustrated in the following diagram.

- Metal casing around the receiver may form a Faraday cage around the receiver attenuating the signal. A metal cage may also change the orientation of the magnetic field coming from the transmitter.
- Interference created by other electronic devices (such as motors, displays and power supplies) may interfere with the transmission of information from the transmitter to receiver. Optimally the HRMI will be physically separated from such sources of electro-magnetic energy.

### 3.3.4 Microcontroller

Without microcontroller, the information is useless because the desire output cannot be generated. Therefore, the heart rate strap worn on the chest will communicate with RMCM01 to transmit the data while the microcontroller will process the data and display the result on LED strip. The information of heart rate will be interpreted and then get the output by programming PIC18F452 using MikroC Pro.

Power supply and crystal are required for a microcontroller in order to make it can operate. The typical power supply required for the PIC18F452 is 5V power supply. However, the adapter used provides 9V. Therefore, the voltage regulator (LM7805) is needed to convert 9V to 5V. While, the crystal used in this microcontroller is 20 MHz.

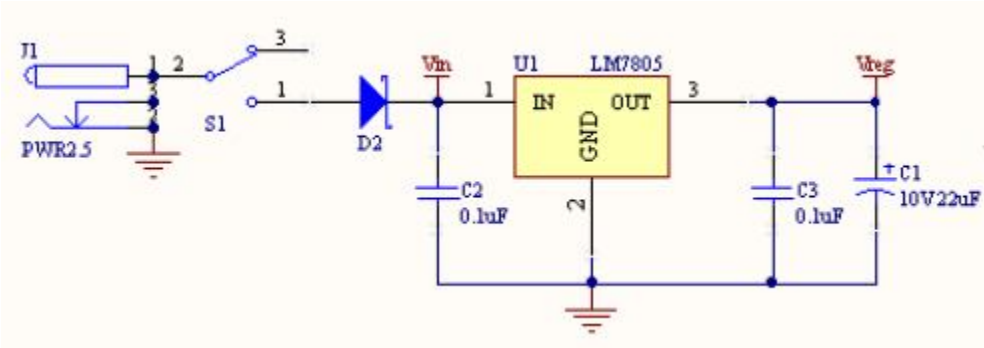



**Figure 3.8** : Voltage regulator

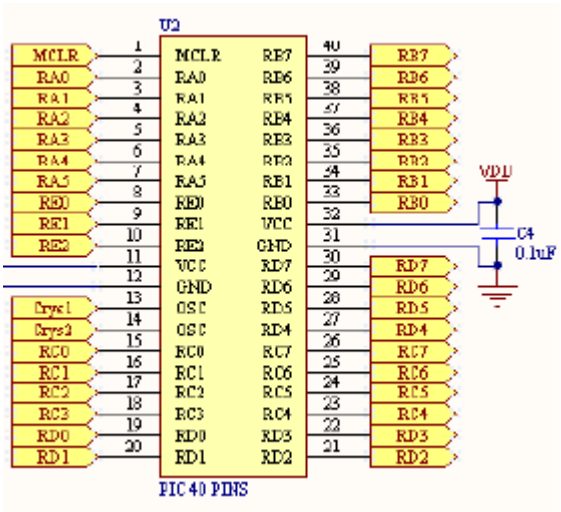



**Figure 3.9** : Schematic of PIC18F452

**Table 3.2** : PIC18f452 pin connection

| Port/Pin name | Description | Connect to |
|---|---|---|
| RB0 | Input | RMCM-01 |
| RD3-RD7 | Output | LED strip |
| RC0-RC5 | Output | LCD |

### 3.3.5 LED Indicator

The flexible LED strip namely LED Deco Flex has been chosen to be used in this project. It can display a multicolour depend on the user's programming. So, it is suitable to be used in this project where the output need to be change according to

the heart rate measured without need to use so many led or different colour of lamp. The strips are driven using HL1606 chips which are commonly used. HL1606 is a LED driver IC with SPI controlled. SPI is a serial bus protocol that is supported in hardware by the Atmel AVR CPU used on the Arduino boards [22].

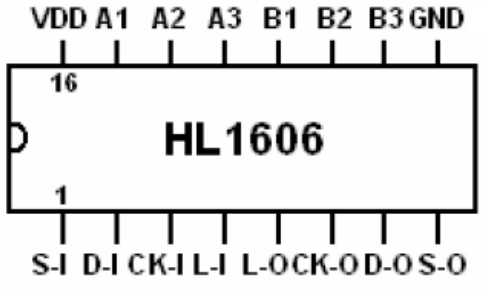



**Figure 3.10** : Diagram of HL1606

**Table 3.3** : Pin definition of HL1606

| No. | Name | Description | No. | Name | Description |
|---|---|---|---|---|---|
| 1 | S-I | Sync / speed clock input | 7 | D-O | Data buffer output |
| 2 | D-I | Data input | 8 | S-O | Sync / speed clock buffer output |
| 3 | CK-I | Clock input | 9 | GND | GND |
| 4 | L-I | Latch signal input | 10~12 | B3~B1 | 3 way drive output |
| 5 | L-O | Latch signal buffer output | 13~15 | A3~A1 | 3 way drive output |
| 6 | CK-O | Clock buffer output | 16 | $V_{DD}$ | VDD |

### 3.3.6 Liquid Crystal Display

In this project, LCD also acts as an output. It will display the type of emotion of a person's with the range of heart rate. The type of LCD used is 2x16 means that it will display word or number in two lines only. The connections of the LCD are as in the figure 3.11.

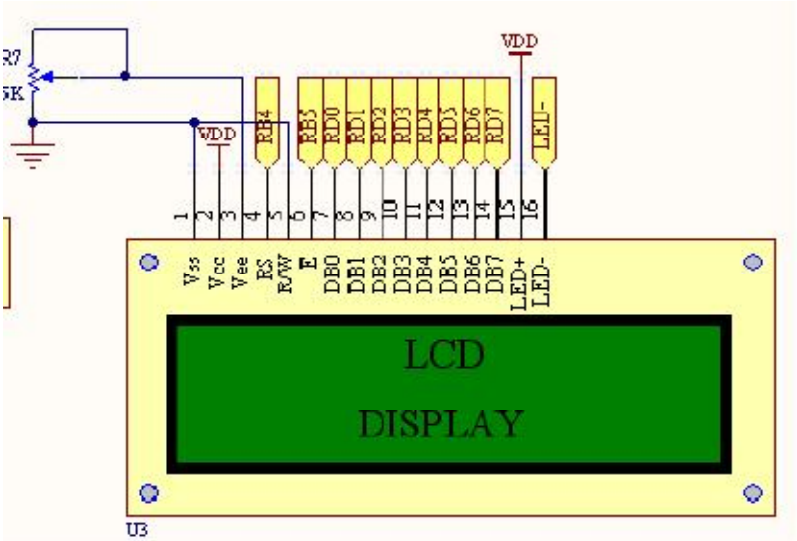



**Figure 3.11** : Connection of LCD display

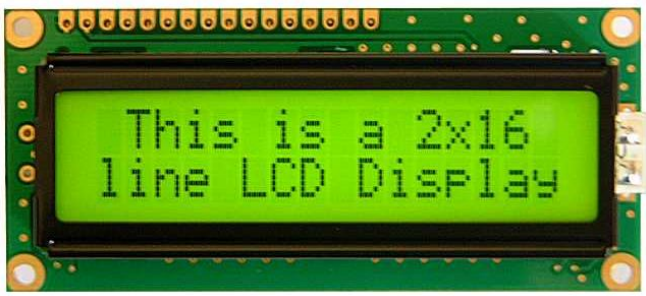



**Figure 3.12** : 2x 16 LCD

## 3.4 Software Development

For this part, the software for microcontroller which is PIC18F452 is discussed. The microcontroller was compiled by using MicroC Pro by using C programming language which is one of the high levels programming language.

### 3.4.1 MikroC Pro

Generally, the function of microcontroller for this project is actually to detect person' heart rate which will be sent to it through polar receiver wirelessly. The data received is in pulse corresponding to each heart beat. Digital pulse generated by writing an algorithm in the programming.

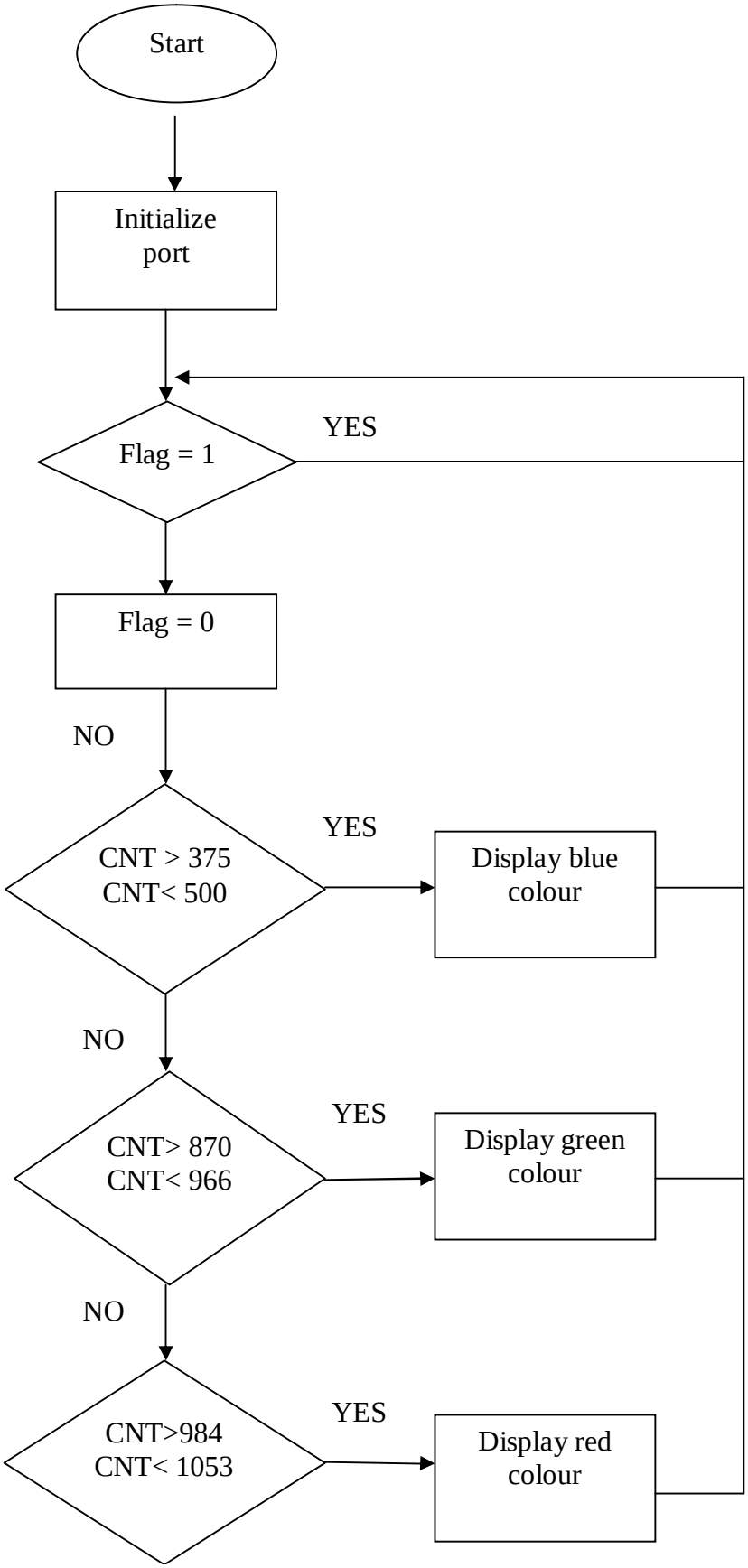



**Figure 3.13** : Flowchart of MikroC Programming

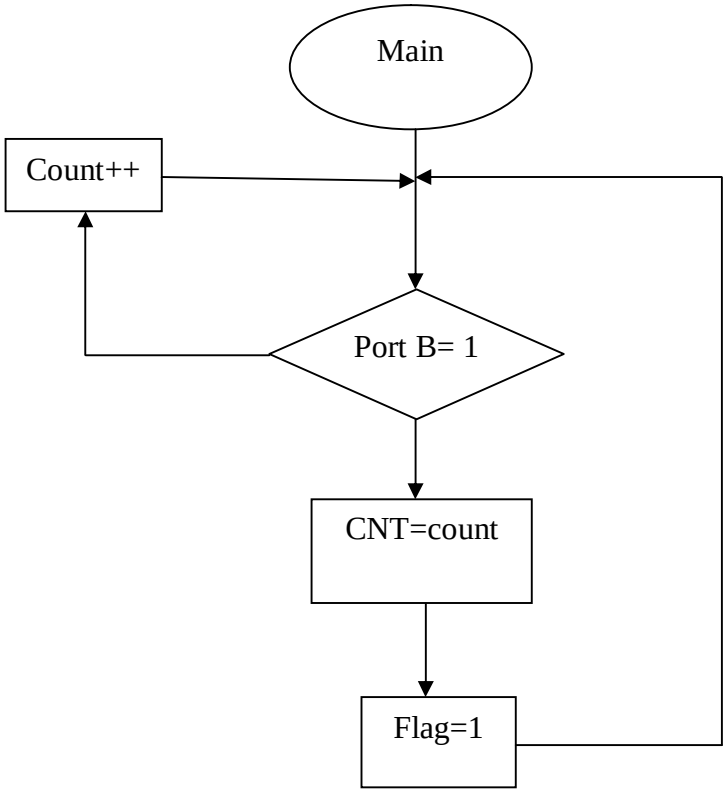



**Figure 3.14** : Flowchart of MikroC programming

In order to display the output on the LED strips and LCD, a heart rate receiver connected to a PIC microcontroller as shown in Table 3.2. The PIC microcontroller was programmed in C to measure the time between heart beats, displays the beats per minute (BPM) and the time (time in ms) between consequent heart beats.

As to program the LED strip, the explanation about it discussed as follow. The first three pins are the standard SPI. As to control the speed of the LED fade, the fade clock was used.

**Table 3.4** : LED control byte format

| Bit | Definition |
|---|---|
| 0 | Blue LED control bits |
| 1 | |
| 2 | Red LED control bits |
| 3 | |
| 4 | Green LED control bits |
| 5 | |
| 6 | Fade rate bit, 0 = slow (127 steps), 1 = fast (63 steps) |
| 7 | Buffer latch bit, 1 = latch, 0 = don't latch |

The HL1606 has two parts, two shift buffers (A & B) and two output drivers (A & B) [22]. Data on the input pin is shifted into the shift buffers, and then copied, under the control of the L-1 line, into the output buffers to drive the two LEDs connected to the chip. It shifts the contents of the A buffer into the B buffer when data is shifted into each chip and the contents of the B buffer are passed on to the next chip in the chain.

As to drive data to the strip, the following instructions need to be done:

1. Set L-I low to select the chip.
2. For each control byte to be sent, send the bits in MSB order as follows
    - Transfer a bit to the chip by setting the D-I pin high for 1, low for 0
    - Send a clock pulse (high/low) on CK-I
3. Set L-I high to deselect the chip.

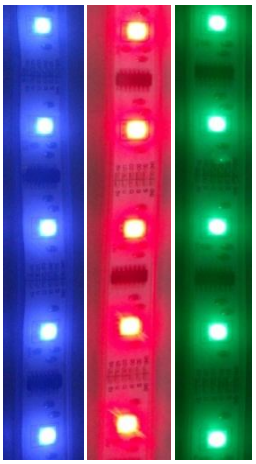
At the start of transferring the data, it is very important to set L-I low first and then pull it high after transferring all the bytes. This is necessary because the state of L-I governs what is done with the data shifted in to the chip. If L-I is active the chip transfers the data along the shift buffer chain but doesn't copy it into the output drivers, so nothing is visible as the data is being shifted down the chain. When L-I is pulled high the current data is transferred from the A & B shift buffers in to the corresponding output drivers and the LEDs are lit appropriately.

Each LED uses two bits to specify its setting as shown in the table below. As we can see, the first two combinations is simple, the LEDs are either fully ON or fully OFF.

**Table 3.5** : LED control bit format

| **Bit 0** | **Bit 1** | **Definition** |
|---|---|---|
| 0 | 0 | LED off |
| 0 | 1 | LED on |
| 1 | 0 | LED off, fade up on fade clock |
| 1 | 1 | LED on, fade down on fade clock |

There are eight possible colors that can be displayed by the LED strips. The combinations are as shown in the table 3.6. However, in this project, there are only three colors was used which are blue, red and green.



Code of programming:

Blue : Soft_SPI_Write(0b10110000)
Red : Soft_SPI_Write(0b10001100)
Green : Soft_SPI_Write(0b10000011)

**Table 3.6** : Available color

| **Red** | **Green** | **Blue** | **Visible colour** |
|---|---|---|---|
| Off | Off | Off | Off |
| On | Off | Off | Red |
| Off | On | Off | Green |
| Off | Off | On | Blue |
| Off | On | On | Cyan |
| On | Off | On | Magenta |
| On | On | Off | Yellow |
| On | On | On | White |

# CHAPTER 4

# RESULT AND DISCUSSION

## 4.1 Introduction

This chapter will discuss about the result obtained from this project and some discussion related to the output from this project. There are all about the hardware and software of this mood controlled light project.

## 4.2 Hardware

To design the circuit of mood controlled light, Altium design was used. This software was used because the size of the Printed Circuit Board (PCB) will be smaller. However, there are some short circuit occur on that PCB which then SK40C has been used.

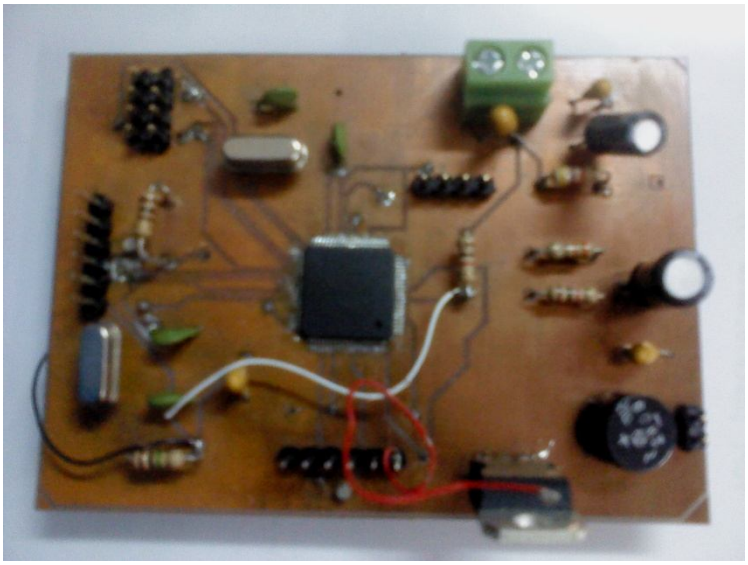
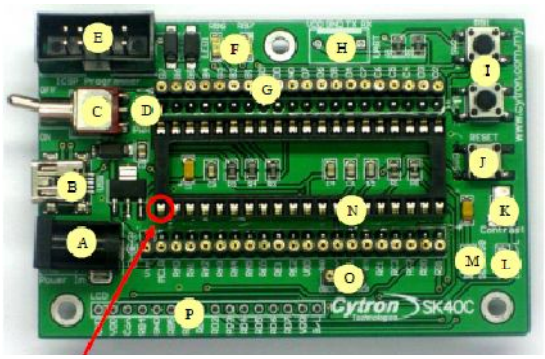


**Figure 4.1** : First design by using Altium design

SK40C is another enhanced version of 40 pins PIC microcontroller start up kit. It is designed to offer an easy to start board for PIC MCU user. This kit is used because it offer[23]:

- Save development and soldering time
- No extra components required for the PIC to function
- All 33 I/O pins are nicely labeled to avoid miss-connection by users
- Connector for UIC00A (low cost USB ICSP PIC Programmer) - simple and fast method to load program
- No more frustrated work plugging PIC out and back for re-programming
- Perfectly fit for 40 pins 16F and PIC18F PIC
- 2 x Programmable switch
- 2 x LED indicator
- LCD display (optional)
- UART communication
- USB on board.
- And all the necessities to eliminate users difficulty in using PIC




Pin 1

**Figure 4.2** : Top view

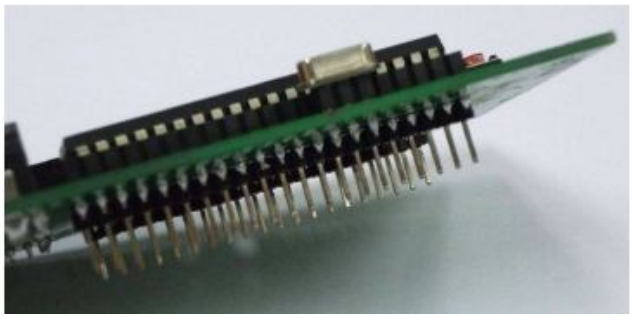


**Figure 4.3** : Side view

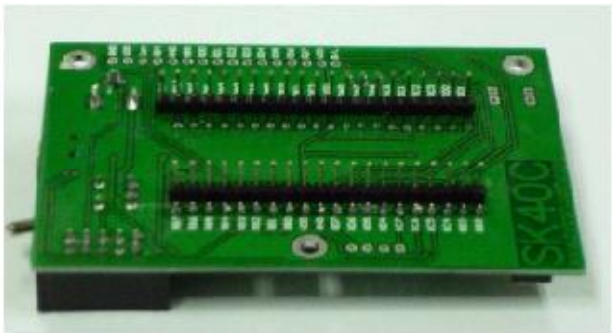


**Figure 4.4** : Bottom view

**Table 4.1** : Pin descriptions of SK40C

| Label | Function | Label | Function |
|---|---|---|---|
| A | DC power adaptor socket | I | Programmable Push Button |
| B | USB Connector | J | Reset button |
| C | Toggle Switch for power supply | K | LCD contrast |
| D | Power indicator LED | L | JP8 for LCD Backlight |
| E | Connector for UIC00A Programmer | M | JP9 for USB |
| F | LED Indicator | N | 40 pin IC socket for PIC MCU |
| G | Header pin and turn pin | O | Turn pin for crystal |
| H | UART Connector | P | LCD Display |

## 4.3 Software

```
//  ByteToStr(number, txtcount); // convert Timems to string
//  Lcd_Out(2,1,txtcount);       // display Timems string on LCD
  if(CNT>375&&CNT<500){          // When heart rate is in normal range (30-240BPM)
     portb.f7 = 1;
     portb.f6 = 0;
        Lcd_Cmd(_LCD_CLEAR);         // Clear LCD
        Lcd_Cmd(_LCD_CURSOR_OFF);    // Cursor off
        Lcd_Out(1,1,"ANXIETY");
        Lcd_Out(2,1,"BPM = 120 to 160");
       for(i=0;i<9;i++){
     CHIP_SELECT = 0;
     FADE_SELECT=1;
     Soft_SPI_Write(0b10110000); //BIRU
     FADE_SELECT=0;
     CHIP_SELECT = 1;    }
    //  delay_ms(50);
     }
```

**Figure 4.5** : Programming for anxiety emotion

```
else if(CNT>984 && CNT < 1053){
  portb.f7 = 0;
 portb.f6 = 1;
    Lcd_Cmd(_LCD_CLEAR);         // Clear LCD
    Lcd_Cmd(_LCD_CURSOR_OFF);    // Cursor off
    Lcd_Out(1,1,"SLEEP");
     Lcd_Out(2,1,"BPM = 57 to 61");
   for(i=0;i<9;i++){
 CHIP_SELECT = 0;
  FADE_SELECT=1;
   Soft_SPI_Write(0b10001100);     //RED
  FADE_SELECT=0;
  CHIP_SELECT = 1;       }
//    delay_ms(50);
}
```

**Figure 4.6** : Programming for sleepy emotion

```
else if(CNT>984 && CNT < 1053){
  portb.f7 = 0;
 portb.f6 = 1;
    Lcd_Cmd(_LCD_CLEAR);         // Clear LCD
    Lcd_Cmd(_LCD_CURSOR_OFF);    // Cursor off
    Lcd_Out(1,1,"SLEEP");
     Lcd_Out(2,1,"BPM = 57 to 61");
   for(i=0;i<9;i++){
 CHIP_SELECT = 0;
  FADE_SELECT=1;
   Soft_SPI_Write(0b10001100);     //RED
  FADE_SELECT=0;
  CHIP_SELECT = 1;       }
//    delay_ms(50);
}
```

**Figure 4.7** : Programming for resting emotion

From the Figure 4.5, 4.6 and 4.7, it shows that the software was developing to generate the output on the LED indicator. While, the below figure show that the programming was compiled and finished successfully.

Messages

Errors Warnings Hints

| Line | Message No. | Message Text |
|---|---|---|
| 0 | 1 | mikroCPIC1618.exe -MSF -DBG -pP18F452 -DL -O11111114 -fo8 -N"D:\ENG. ELECTRIC-ELCTRONI. |
| 0 | 1139 | Available RAM: 1515 [bytes], Available ROM: 32768 [bytes] |
| 0 | 126 | All files Preprocessed in 265 ms |
| 0 | 122 | Compilation Started |
| 160 | 123 | Compiled Successfully |
| 0 | 127 | All files Compiled in 515 ms |
| 0 | 1144 | Used RAM (bytes): 81 (5%) Free RAM (bytes): 1434 (95%) |
| 0 | 1144 | Used ROM (bytes): 1089 (3%) Free ROM (bytes): 31679 (97%) |
| 0 | 125 | Project Linked Successfully |
| 0 | 128 | Linked in 2745 ms |
| 0 | 129 | Project 'fullproject.mcppi' completed: 6193 ms |
| 0 | 103 | Finished successfully: 16 May 2011, 02:50:42 |

**Figure 4.8** : Messages in the MikroC Pro

## 4.4 Result

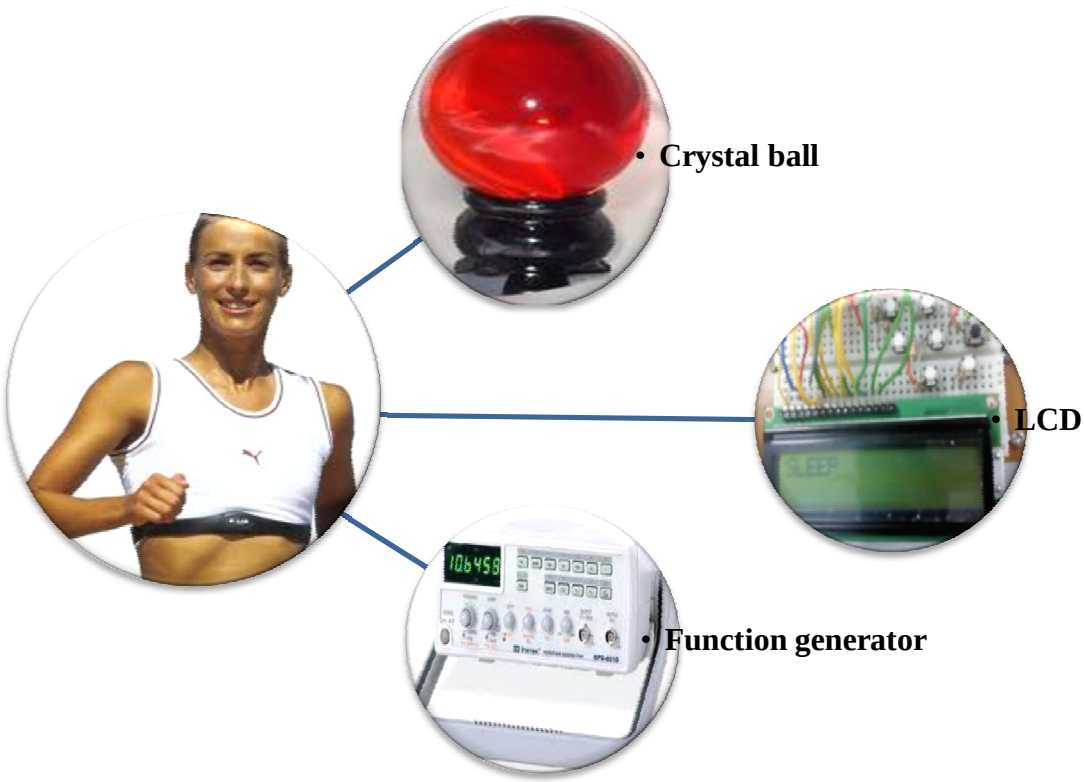
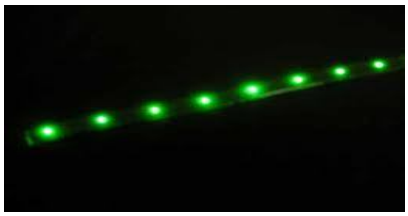
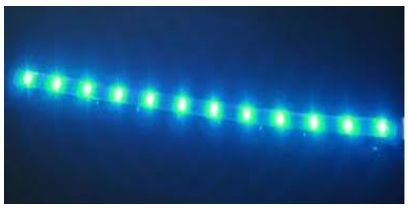



**Figure 4.9** : Relation between the input and output

Figure 4.9 shows the relation between the input and output. Means when the heart rate was measured by chest strap, the microcontroller will process the data received. Then, the crystal ball will change the environment colour according to the table 4.2 as shown below. Meanwhile, the LCD will display the range of heart rate including the type of emotion at that time. Function generator also was used as to display the frequency of the heart rate to ensure that the programming is correct.

**Table 4.2 :** Result obtained from the overall project

| **Range of heart rate (bpm)** | **Emotion** | **Output colour** |
|---|---|---|
| 57-61 | Sleepy | Red |
| 62-69 | Resting | Green  |
| 120-160 | Anxiety | Blue  |

## 4.5 Discussion

First, the person's mood was measured by wearing T31 Transmitter on the chest. The distance between the transmitter and receiver need to follow the rules as discussed in Chapter 3 to ensure that the information of the heart rate can be gained precisely. Once the heart beat detected, it will transmit the data to the RMCM-01 wirelessly. The microcontroller interpreted the data and decided the range of the person's heart rate which in this case PIC18F452 was used. The PIC was already been programmed according to the desire output and it can communicate with the hardware.

There will be three range of heart rate which represents three emotions that are anxiety, sleepy and resting. If the LCD display the output is anxiety in the range of 120-160 bpm, then the LED strip will turn to blue colour. This is because blue will stimulate clear thought and lighter[24]. Besides, it will calm the mind [24]. Therefore, we can say that, blue colour can stabilize the person's emotion from anxiety to cool and be more relax.

Second emotion is sleepy. The range of heart is between 57-61 bpm. Once this range of heart rate detected, the LED strip will change to red colour while the LCD will display sleepy with its range of heart rate. In order to make sleepy people more energetic, the LED strips need to change to red colour. This is because red can stimulate and raise the pulse rate[24]. So, sleepy people will feel fresh and wake up. This condition most suitable to be used in the environment class which especially for student.

The last emotion that will be discussed is resting. From previous research, the range of heart rate during resting is in the range of 62-69 bpm. If the data transmit is in this range, the output colour will turn to the green. On the hand, the LCD will display the ouput resting, BPM= 62-69 bpm. Green is the symbol of balance and resting mode[24]. That is why the output colour of green can stabilize the pers emotion in this mode.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATION

## 5.1 Introduction

Generally, this chapter will be about the conclusion for overall of this project. Besides, the recommendations for future development are also will be explained in this chapter.

## 5.2 Conclusion

Numerous studies have demonstrated that different emotions are associated with different patterns of autonomic nervous system (ANS) activity, as measured by heart rate variability (HRV)[25]. Actually, emotion can affect the way of heart beat. By managing person's emotion, it may improve the heart beat. That is why this project has been done.

The emotional state of a person is very important because it can affect health and the activity of that person. If a person has negative emotion during attending a lecture for example, then it can give impact to him. This is because he cannot give attention and focusing to the lecture in front. That is why this project was carried out and hopefully by changing the environment color the person's mood can be handle well. The first objective of this is to measure the heart rate of a person by using heart rate monitor. This objective was successfully done where the polar heart rate monitor was used. However, the result of heart rate measured is not really can be say as an emotion. This is because from the project, the data that was gained only heart rate. So, the value of heart rate cannot determine the emotion of a person exactly.

Moreover, the software of MikroC has successfully developed as to change the environment color. The color will change according to the three range of heart rate which is sleepy, anxiety and resting. If the person is sleepy, then the color will change to red. This is because red will make the person more energetic. On the other hand, when the person is in an anxiety mood, the LED strip will turn to blue color as to stimulate the pulse rate. The last emotion studied in this project is resting mode. When the person is in resting mode, the color will change to green. This is because green is believable as a symbol of balance and resting mode.

## 5.3 Recommendations

From this project the exact emotion of a person is not really accurate. This is because the other measurement other that heart rate also needs to be done to obtain the correct one. Here, there are a few recommendations for future development:

- Detect person's mood by using other method such as measuring body temperature.
- Find more range of heart rate for other emotions such as happy, depression and angry.

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## APPENDIX A

## MikroC Pro programming for Mood Controlled Light

```
 // LCD module connections
sbit LCD_RS at RC4_bit;
sbit LCD_EN at RC5_bit;
sbit LCD_D4 at RC0_bit;
sbit LCD_D5 at RC1_bit;
sbit LCD_D6 at RC2_bit;
sbit LCD_D7 at RC3_bit;
sbit LCD_RS_Direction at TRISC4_bit;
sbit LCD_EN_Direction at TRISC5_bit;
sbit LCD_D4_Direction at TRISC0_bit;
sbit LCD_D5_Direction at TRISC1_bit;
sbit LCD_D6_Direction at TRISC2_bit;
sbit LCD_D7_Direction at TRISC3_bit;
// End LCD module connections

sbit SoftSpi_SDI at RD2_bit;
sbit SoftSpi_SDO at RD6_bit;
sbit SoftSpi_CLK at RD3_bit;

sbit SoftSpi_SDI_Direction at TRISD2_bit;
sbit SoftSpi_SDO_Direction at TRISD6_bit;
sbit SoftSpi_CLK_Direction at TRISD3_bit;

#define CHIP_SELECT PORTD.F4     //LI
#define FADE_SELECT LATD.F7      //SI
#define DI LATD.F6       //DI
#define CI PORTD.F3      //CI

unsigned char i;
unsigned int CNT, count=0,state;
```

```
unsigned short DisplayBPMflag = 0;
unsigned short BPM;
unsigned int number;
char txtBPM[6],txtcount[]="00000" ;
//char txtBPM[6],txtTimems[6] ;
void TMR0_ON(void);
void interrupt()
{ //<<<<<<generate servo PPM using TMR0 intrrupt>>>>>
  if(INTCON.TMR0IF==1)
   {  //portc.f0=~portc.f1;  //testing interrupt time
     if (PORTB.F0==0){ state = 1;                    // check RB7 on rising edge
     //   if (state ==1 && PORTB.B1==1){
       CNT = count;                      // Copy count2 value to CNT
       count = 0 ;                      // reset count2 value
       DisplayBPMFlag = 1;
       state = 0;       // }       // set flag that the BPM can be put to LCD in the main loop
      }
    count++;
    TMR0L=164; //164
    INTCON.TMR0IF=0;

   }
}

void main(){
//    ANSEL = ANSELH  = 0;       // ALL set as Digital I/O
    TRISB = 0x0f;              // Set RB7 and RB6 as input, rest is output
    OSCCON=0b00011101;
    ADCON1 = 0X0F;
    TRISC = 0X00;
    TRISE = 0X00;
    TRISD=0x00;

    Lcd_Init();               // Start LCD
```

```
Lcd_Cmd(_LCD_CLEAR);        // Clear LCD
Lcd_Cmd(_LCD_CURSOR_OFF);   // Cursor off
TMR0_ON();
 // Write text in first row
while(1){                        // program loops around in here

    if(DisplayBPMFlag == 1){

    DisplayBPMFlag = 0;     // clear displayBPMflag
   /*CHIP_SELECT = 0;
    FADE_SELECT=1;
    Soft_SPI_Write(0b10001011);
    FADE_SELECT=0;
    CHIP_SELECT = 1;*/

    //  ByteToStr(number, txtcount); // convert Timems to string
    //  Lcd_Out(2,1,txtcount);      // display Timems string on LCD
      if(CNT>375&&CNT<500){          // When heart rate is in normal range (30-
240BPM)
        portb.f7 = 1;
        portb.f6 = 0;
          Lcd_Cmd(_LCD_CLEAR);        // Clear LCD
          Lcd_Cmd(_LCD_CURSOR_OFF);   // Cursor off
          Lcd_Out(1,1,"ANXIETY");
          Lcd_Out(2,1,"BPM = 120 to 160");
         for(i=0;i<9;i++){
        CHIP_SELECT = 0;
        FADE_SELECT=1;
        Soft_SPI_Write(0b10110000); //BIRU
        FADE_SELECT=0;
        CHIP_SELECT = 1;   }
       //  delay_ms(50);
        }
      else if(CNT>870&&CNT<968){
```

```
    portb.f7 = 0;
    portb.f6 = 1;
      Lcd_Cmd(_LCD_CLEAR);        // Clear LCD
      Lcd_Cmd(_LCD_CURSOR_OFF);   // Cursor off
      Lcd_Out(1,1,"REST");
      Lcd_Out(2,1,"BPM = 62 to 69");
      delay_ms(100);
      for(i=0;i<9;i++){
    CHIP_SELECT = 0;
    FADE_SELECT=1;
    Soft_SPI_Write(0b10000011);    //GREEN
    FADE_SELECT=0;
    CHIP_SELECT = 1;    }
  //   delay_ms(50);
        }
   else if(CNT>984 && CNT < 1053){
    portb.f7 = 0;
   portb.f6 = 1;
      Lcd_Cmd(_LCD_CLEAR);        // Clear LCD
      Lcd_Cmd(_LCD_CURSOR_OFF);   // Cursor off
      Lcd_Out(1,1,"SLEEP");
       Lcd_Out(2,1,"BPM = 57 to 61");
     for(i=0;i<9;i++){
   CHIP_SELECT = 0;
    FADE_SELECT=1;
     Soft_SPI_Write(0b10001100);    //RED
    FADE_SELECT=0;
    CHIP_SELECT = 1;      }
  //    delay_ms(50);
  }

  //ByteToStr(BPM, txtBPM);       // convert BPM to string
// Lcd_Out(2,1,txtBPM);          // display BPM string on LCD
```

```
          INTCON.TMR0IF=0;
          }
        else {
          }
   }
}

void TMR0_ON(void)
{
TMR0L=164;//TMR0H=0X80;       //give TMROH:TMROL = 32896 (maximum val
= 65535)
INTCON=0B11100000;      //enable all unmasked interrupt & TMR0 overflow int
T0CON=0B11001000;       //enable 8bit TMR0, internal clock, no prescale

}  //0.05ms
```